colloquium-journal

ISSN 2520-6990

Międzynarodowe czasopismo naukowe

Medical sciences
Technical science
Agricultural sciences

№8(95) 2021
Część 1

colloquium-journal

ISSN 2520-6990

ISSN 2520-2480

Colloquium-journal №8 (95), 2021

Część 1

(Warszawa, Polska)

«Colloquium-journal»
Wydrukowano w Annopol 4, 03-236 Warszawa Poland, «Interdruk»
E-mail: info@colloquium-journal.org
http://www.colloquium-journal.org/

CONTENTS

MEDICAL SCIENCES

AGRICULTURAL SCIENCES

TECHNICAL SCIENCE

УДК 631.35:636.085

Холодюк О. В.
кандидат технічних наук, старший викладач кафедри агроінженерії та технічного сервісу
Вінницький національний аграрний університет
Кузьменко В.Ф.
кандидат технічних наук, старший науковий співробітник відділу "Біотехнічних систем в тваринництві та заготівлі кормів"
Національний науковий центр "Інститут механізації та електрифікації сільського господарства"
DOI: 10.24412/2520-6990-2021-895-39-44

ВИЗНАЧЕННЯ КУТА ЗАЩЕМЛЕННЯ В РІЗАЛЬНІЙ ПАРІ ПАЛЕЦЬ ЖИВИЛЬНОГО РОТОРА-ДИСКОВИЙ НІЖ

Kholodiuk O.V.
Candidate of Technical Sciences,
Senior teacher of the Department of Agricultural Engineering and Technical Service,
Vinnytsia National Agrarian University
Kuzmenko V.F.
Candidate of Technical Sciences, Senior Research Fellow,
Department of Biotechnical Systems in Animal Husbandry and Feed Stockpiling
National Research Center "Institute of Mechanization and Electrification of Agriculture"

DETERMINATION OF JAMMING ANGLE IN THE CUTTING PAIR OF FINGER FEEDING ROTOR AND DISC KNIFE

Анотація
В статті обґрунтовано вибір параметрів живильного ротора і дискових ножів шляхом встановлення залежностей для визначення кута защемлення в різальній парі подрібнювального апарату та визначення його зміни на прикладі використання прямолінійного радіального пальця ротора та дискового ножа. Наведені рівняння, які дозволяють визначити кут защемлення трав'яної маси між радіальним пальцем ротора і крайкою дискового ножа та між ребром барабана та дисковим ножем. Також представлені залежності, що дозволяють встановити значення радіуса ротора, довжини пальця ротора та діаметр дискового ножа. Обґрунтовано, що дискові ножі у запропонованому подрібнювальному апараті раціонально встановлювати у IV квадранті з величиною кута λ в межах від 30^o до 60^o.

Abstract
The article substantiates the choice of parameters of the feeding rotor and disc knives by establishing the dependences to determine the jamming angle in the cutting pair of the shredding machine and determine its change on the example of using a rectilinear radial finger of the rotor and disc knife. The equations are given to determine the angle of jamming of the grass mass between the radial finger of the rotor and the edge of the disc knife and between the edge of the drum and the disc knife. It has been substantiated that disk knives in the proposed shredding device should be rationally installed in the IV quadrant with the value of the angle λ in the range from 30^o to 60^o.

Ключові слова: *кут заклинювання, ротор подачі, дисковий ніж, палець, подрібнювач, барабан, збивач.*
Keywords: *jamming angle, feeding rotor, disc knife, finger, shredding machine, drum, beater.*

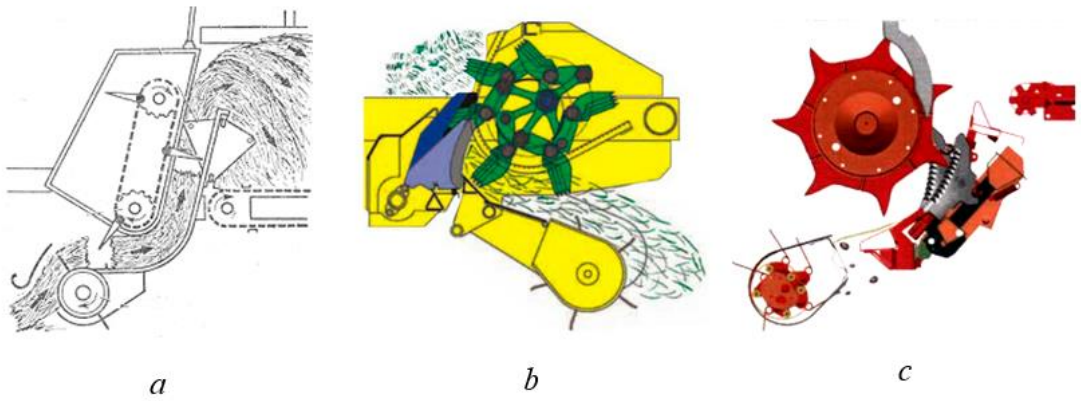
Problem statement. A stable level of development of the livestock industry is not possible without a sufficient number of high-quality and nutrient-balanced feeds.

At present, all types of stem fodder are used on farms of the agro-industrial complex of Ukraine: hay, haylage, silage, green fodder, using, at the same time, annual or perennial grasses, as well as in combination with cereals. The choice of existing harvesting technologies depends on the crop grown, the type of feed required, the method of harvesting, and the available amount of energy and machinery on the farm.

Variety of designs, availability of combines of different productivity, strengthening of requirements to indicators of quality of grinding, economic requirements concerning prime cost of gathering of stalk forages cause necessity in validity and prospects both technological schemes of combines, and new design decisions of their main working bodies, including the grinding device.

Bitter-knife multi-plane cutting devices are becoming more common in forage harvesting equipment (pick-up trucks, round and large-pack balers, etc.) [1, 2, 3, 4]. However, today there is no systematic description of the process of operation of such devices, the main dependencies have not been identified, which would determine the productivity, energy consumption and quality indicators of this type of grinding machines.

Analysis of researches and publications. In the process of development beater-knife grinding machines in forage harvesters have gone through the process of cutting from cutting in a straight channel with a straight finger beater on straight knives (Fig. 1, *a*) to cutting in a concentric channel with a finger with a spiral working surface on the knife with spiral working edge (Fig. 1, *b*, *c*).



a *b* *c*

Fig. 1. Constructional and technological schemes of bitumen-knife shredding machines:
a) - with a rectilinear channel for the movement of plant mass;
b) - with a circular canal and controlled fingers of the beater;
c) - with a circular channel and a feeding rotor

In modern models of pick-up trucks and balers a simpler and more reliable rotary feeder is used (Fig. 1, *c*). It contains a cylindrical drum on the surface of which curved fingers are fixed, thus forming a star-shaped shape. The number of fingers around the circumference of the drum varies from 2 to 9 depending on the diameter. This design of the feeding device allows it to be used both in pick-up trucks and balers. The stem mass in them is selected from the roll by a sorter and fed into the area of rotation of the fingers of the rotary feeder. Then it is grasped by a pair of fingers and stretched along the forming channel on the plate knives. Then the crushed stem mass is pushed into the pressing chamber of the baler or into the trailer of the pick-up truck. The proposed design of the biter-knife shredding machine provides for the installation of active disc knives instead of passive concave ones with a spiral cutting edge [5]. The analysis of work of the shredding machine allows to allocate three components of the process:

- capturing and compressing the mass with a beater and feeding it into the channel;
- pushing the mass with simultaneous cutting along the channel;
- the output of the beater fingers from the channel without tightening the mass with fingers.

The main working units of such a device are a finger pick-up, which is closed by casings, a feeding rotor, a channel formed by protective casings of a beater and a disk knife. The protective cover covers the beater and forms the upper part of the channel, and the cover is smoothly connected to the guides of the pick-up and forms the lower surface of the channel. The output channel expands. Its lower shield has slots of appropriate width, which includes disc knives.

Formulation of the goals of the article. The aim of the work is to substantiate the parameters of the feeding rotor and disc knives by establishing the dependences to determine the jamming angle in the cutting pair of the shredder and determine its change on the example of using a straight radial finger of the rotor and disc knife.

Presentation of the main research material. The feeding rotor of the shredder includes a drum and a pair of fingers, the number of which along the length of the drum is set by the required length of cutting grass. The parameters of the drum based on the jamming angle of the mass between the edge of the drum and the blade of the disk knife are to be determined.

The jamming angle is the angle formed at the point of contact of the tangent interacting surfaces. Ideally, the angle between the surface of the drum and the edge of the knife at their point of contact is zero. In this case, the stem mass will be tightened at the place of cutting, ie will move in the direction of transportation.

In real conditions, there is a gap $\Delta_{нб}$ = 2-4 mm between the drum and the disc knife, and the knife enters the groove (rib) on the surface of the drum, the depth of which is h_1 = 10-15 mm. In this case, the jamming angle between the knife and the drum is determined at the point of intersection of the knife edge and the edge that forms the groove - point *K* (Fig. 2). The jamming angle will be defined as the angle between the tangents drawn at point *K* to the disc knife (center O_1) and the edge of the drum - (center *O*).

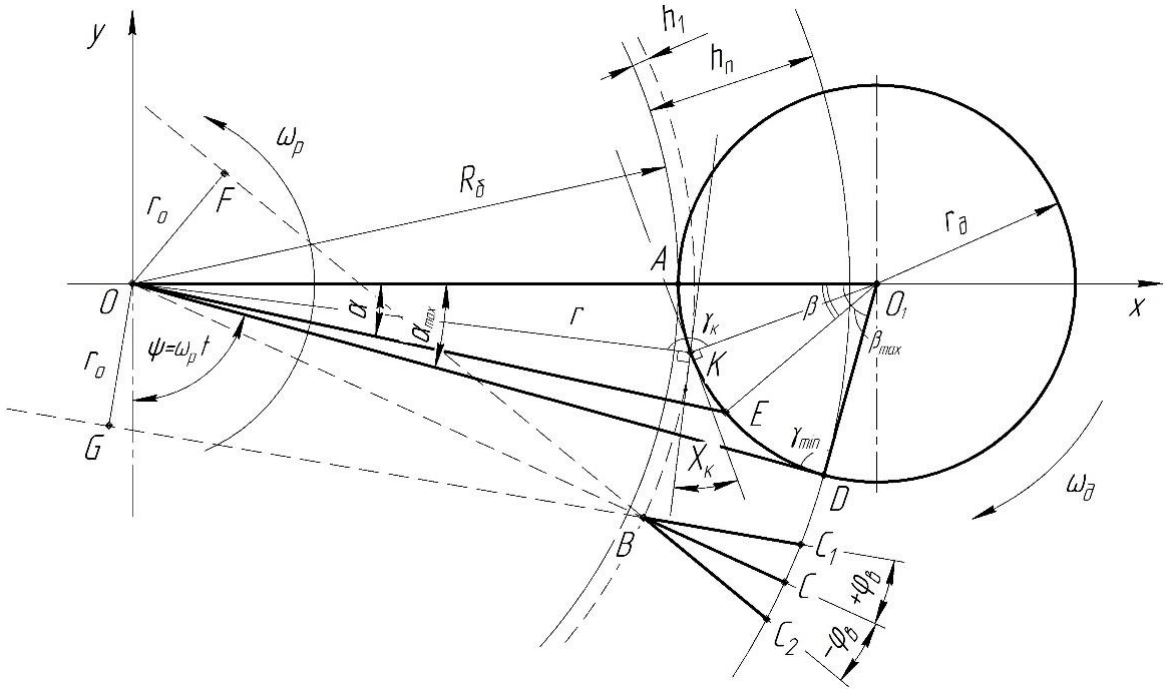


Fig. 2. The scheme for determining the jamming angle of the feeding rotor

From Figure 2 we can write

$$\chi = \pi - \gamma_к, \qquad (1)$$

where χ – jamming angle, rad;

γ_K - angle OKO_1, rad.

We see that the jamming angle χ between the disc knife and the edge of the drum is constant. We are to define it, but first set the angle γ_Ky at the point K with ΔOKO_1, neglecting the value of the gap $\Delta_{иб}$ between the knife and the surface of the drum with a disc knife

$$\gamma_K = \arccos\frac{(R_б + h_1)^2 + r_д^2 - (R_б + r_д)^2}{2(R_б + h_1)r_д} = \arccos\frac{2R_б(h_1 - r_д) + h_1^2}{2(R_б + h_1)r_д}.$$

Then the jamming angle is

$$\chi_K = \pi - \arccos\frac{2R_б(h_1 - r_д) + h_1^2}{2(R_б + h_1)r_д}. \qquad (2)$$

If the value of this angle χ exceeds twice the value of the angle of friction, the plant mass is pushed from the point of intersection of surfaces, if smaller - it moves to the point of intersection of cutting surfaces, with equality ($\chi = 2\varphi$) - the material is stationary [6, 7]. So we can write

$$2\varphi \geq \pi - \arccos\frac{2R_б(h_1 - r_д) + h_1^2}{2(R_б + h_1)r_д}, \qquad (3)$$

where φ – the angle of friction of the grass mass along the edge of the drum and the blade of the disc knife

However, it should be noted that jamming will also occur at $\chi \geq 2\varphi$, as there are forces created by the drum finger, the drum surface and the disc knife, which promote the forced passage of the treated grass mass through the cutting device.

From equation (3) the value of the radius of the drum will be

$$R_б \geq \frac{-h_1 \cdot r_д \cos 2\varphi - 0{,}5h_1^2}{h_1 - r_д + r_д \cos 2\varphi}. \qquad (4)$$

Another place where the grass mass is jammed is the working surface of the finger (its edge) of the drum and the edge of the disc knife. The angle between the finger BC and the cutting edge AD (Fig. 2), which is formed when the point (C_1; C_2) reaches the end of the finger point D of the disk knife and moves along the edge of the knife from point D to point A is the jamming angle, the value of which changes with rotation drum.

The finger of the beater can be both radial BC and inclined forward - BC_1 or back - BC_2 at an angle $\varphi_б$.

Consider the change in the jamming angle for the option with the radial position of the finger. The jamming angle at point D is the angle between the tangent to the cutting edge at point D (forms a right angle with radius O_1D) and the direction of the finger O_1D, ie

$$\chi_D = \gamma_{\min} - \frac{\pi}{2}.$$

For any arbitrary point of the cutting edge between the points D and K, the value of the jamming angle will be determined

$$\chi_{D-K} = \gamma - \frac{\pi}{2}, \qquad (5)$$

where $\chi_{D\text{-}K}$ –jamming angle between the cutting edge and the beater finger on the arc D-K, rad;

γ - the angle at the vertex E on the arc D-K, formed by an arbitrary radius vector r and the radius of the disk knife $r_д$.

The magnitude of the angle is within

$$\gamma_{\min} \leq \gamma \leq \pi.$$

Thus, knowing the values of $R_б$, $r_д$ and h_n for any arbitrary radius vector r lying within $R_б \leq r \leq R_б + h_n$

from the triangle OO_1E by the cosine theorem the angle γ is determined

$$\gamma = \arccos\frac{r^2 + r_\partial^2 - \left(R_б + r_\partial\right)^2}{2r \cdot r_\partial}, \quad (6)$$

where r – radius-vector (distance from the center of the rotor t. O to an arbitrary point, which is located on the arc DA of the disk knife (Fig. 2), m;

r_∂ – radius of a disk knife, m.

Using (6) equation (5) will take the form

$$\chi_{D-K} = \arccos\frac{r^2 + r_\partial^2 - \left(R_б + r_\partial\right)^2}{2r \cdot r_\partial} - \frac{\pi}{2}. \quad (7)$$

In fig. 3 there is a graph of the dependence of the change of the jamming angle χ between the radial finger and the disk knife and the rib of the drum and the disk knife on the angle of rotation of the rotor α.

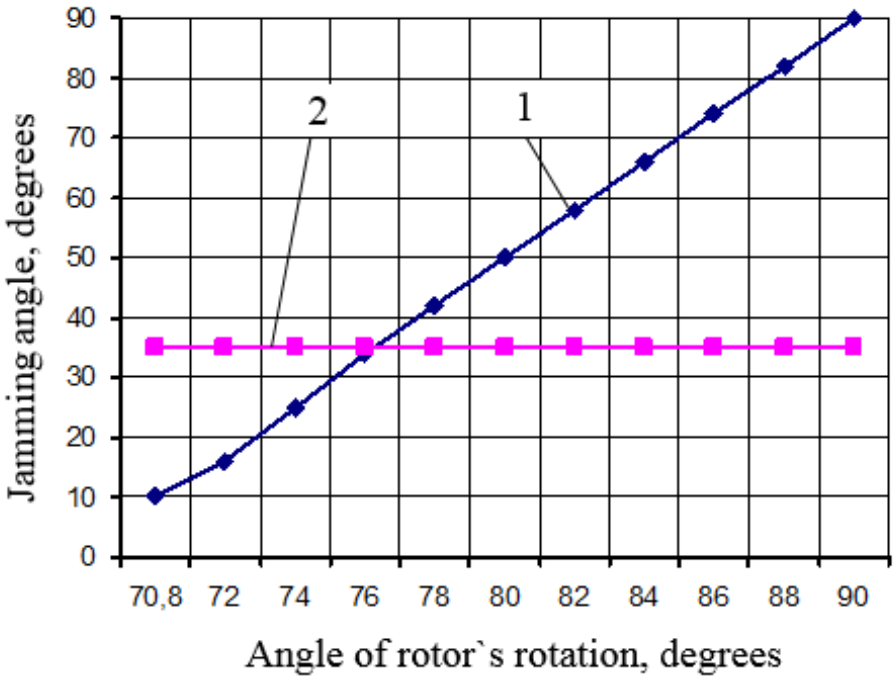


Fig. 3. Graph of the dependence of the jamming angle on the angle of rotation of the rotor between the radial finger of the beater and the disc knife (curve 1) and between the edge of the drum and the disc knife (curve 2) at $R_б$= 0,3m; r_∂ = 0,15 m; h_n = 0,1 m; h_1 = 0,02 m

Thus, the jamming angle of the grass mass between the finger and the disc knife constantly increases when the angle of rotation of the rotor finger changes.

Taking the parameters of the grinding machine equal to D_∂= 0,50 m, D_p= 0,51 m; h_n = 0,18-0,2 m; h_1 = 0,01-0,02 m, the clamping angle takes the value χ_K=33 – 36°, χ_{D-K} = 0 – 57°.

The height of the finger of the feeding rotor and the diameter of the disc knife depend on the height of the feeding channel. Therefore their sizes need to be accepted taking into account backlashes and design features of the biter-knife shredding machine. The recommended height of the feed rotor finger c will be $h_n = b_к$ – (0,01…0,02), and the diameter of the disc knife - $D_\partial = 2b_к$ + (0,05…0,10).

It is necessary to place disk knives in the biter-knife shredding machine proceeding from design considerations and technological process of grinding in the *IV* quadrant (fig. 4).

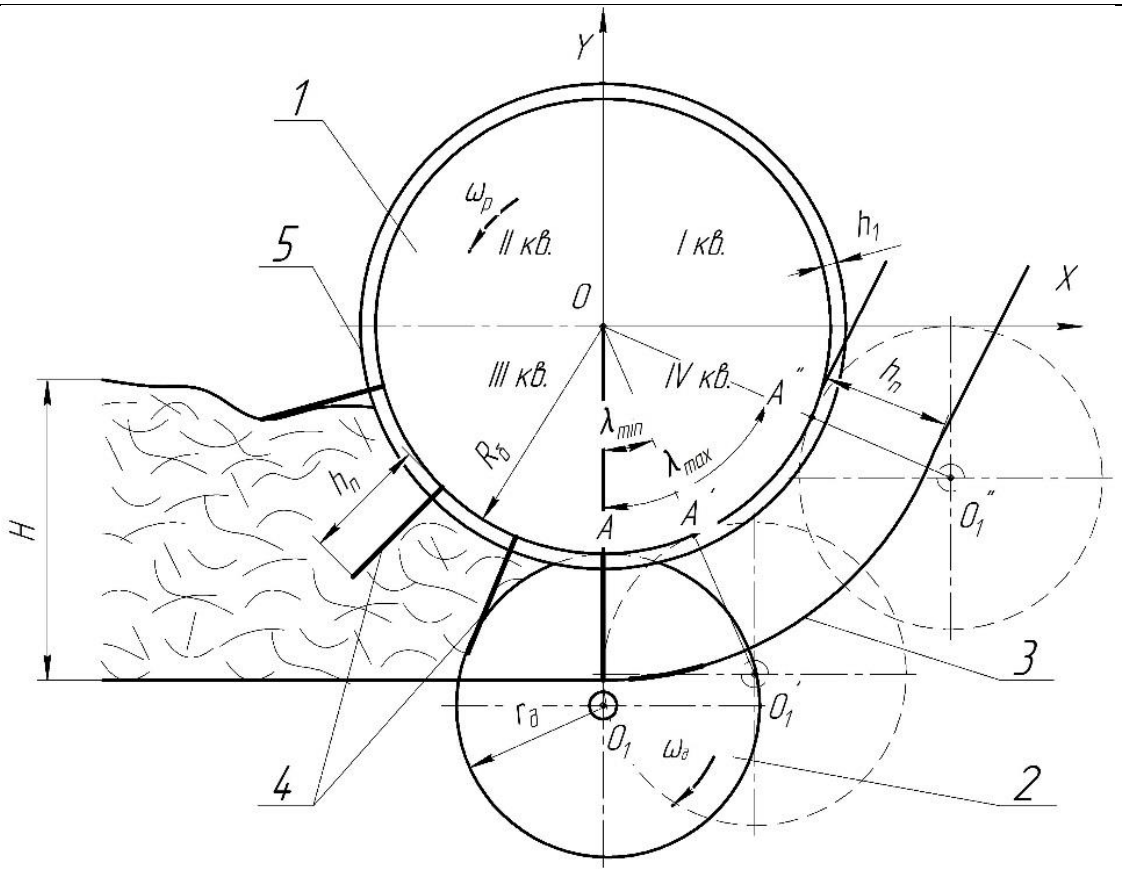


Fig. 4. Schemes for determining the location of disc knives: 1 - drum of the feeding rotor; 2 - disk knife, 3 - the bottom of the channel; 4 - fingers of the feeding rotor; 5 – rib

In order to minimize the size of the device and energy consumption for the process, it is advisable to use rational values of the angle λ. At zero angle λ, part of the cutting edge will be located in the *III* and *IV* quadrants, which will hinder the movement of the grass mass to the ring channel. In addition, in the vertical plane, the dimensions of the shredding machine should be minimal, which is due to the design features of this type of machine from possible damage.

Therefore, the minimum value of the angle λ, where the rotor fingers are guaranteed to push the mass, will be determined from a right triangle with hypotenuse $OO'_1 = R_б + r_д$ and one of the legs of $r_д$ (Fig. 4)

$$\lambda_{\min} = \arcsin \frac{r_д}{R_б + r_д}. \qquad (8)$$

The maximum value of the angle λ_{max}, obviously, must be taken into account the conditions of unloading of the cut mass, which can vary from 0 to $\pi/2$. If we consider the design of pick-up trucks or balers, the angle of installation of the disc knife λ should be taken from 0 to ($\pi/2$-λ_{min}).

Thus, the disc knives in the proposed shredder are rationally installed in the *IV* quadrant (Fig. 4) with an angle λ in the range from 30° to 60°.

Conclusions.

1. When harvesting stem fodder, preference should be given to pick-up trucks, balers in which a biter-knife shredder is used for cutting, which simultaneously with loading by pushing the selected mass ensures its cutting in a closed channel. The technological scheme of the biter-knife shredding machine, which contains a rotary feeding device and a battery of active disc knives, is considered. This design of the device allows to implement the process of cutting with sliding, which reduces the cutting force, and hence the energy consumption of the grinding process as a whole.

2. The dependence (2), which allows to determine the angle χ_K of the clamping material between the disc knife and the drum edge height h_1, and angle $\chi_{D\text{-}K}$ dependence (5) - between the disc knife and the radial finger of the feeding rotor, indicating an increase in the angle χ jamming relative to the finger of the feed rotor and the blade of the disc knife has been obtained.

3. The minimum angle of installation of the disk knife in the forming channel, which should be taken within 30… 60°, has been analytically substantiated.

Література

1. Особов В.И. Механическая технология кормов / В.И. Особов. – М.: Колос, 2009. – 344 с.

2. Kholodiuk O.V., Kholodiuk O.O. Design Features of shredding machines for feeding machines. Slovak international scientific journal. 2020. № 45. Vol. 3. P. 20–31.

3. Zastempowski M., Bochat A. (2015) – New construction of cutting units in selected agricultural machinery, Mechanization in agriculture, year LXI, issue 2, pg. 7-9.

4. Official website of the companyPottinger [Electronic resource]. – Mode of access: https://www.poettinger.at/uk_ua/produkte/kategorie/lw/-

5. Kuzmenko Vladimyr. Исследование влияния параметров измельчающего аппарата на энергоемкость процесса резания / Vladimyr Kuzmenko, Oleksandr Kholodiuk // Motrol: Motorization and power industry in agriculture. – 2016. – Tom 18, № 3. – P. 262–271.

6. Рустамов С.И. Высокопроизводительные режущие аппараты сельскохо-зяйственных уборочных машин / С.И. Рустамов. – Киев-Донецк: Вища школа, – 1985. – 95 с.

7. Даурский А.Н. Резание пищевых материалов: теорія процесса, машины, интенсификация / А.Н. Даурский, Ю.А. Мачихин. – М.: Пищевая пром-сть, 1980. – 240 с.

References

1. Osobov V.I. Mekhanicheskaya tekhnologiya kormov / V.I. Osobov. – M.: Kolos, 2009. – 344 s. [in Russian].

2. Kholodiuk O.V., Kholodiuk O.O. Design Features of shredding machines for feeding machines. Slovak international scientific journal. 2020. № 45. Vol. 3. P. 20–31. [in Ukrainian].

3. Zastempowski M., Bochat A. (2015). New construction of cutting units in selected agricultural machinery, Mechanization in agriculture, year LXI, issue 2, pg. 7-9. [in Bulgaria].

4. Official website of the companyPottinger [Electronic resource]. – Mode of access: https://www.poettinger.at/uk_ua/produkte/kategorie/lw/-

5. Kuzmenko Vladimyr. Issledovaniye vliyaniya parametrov izmel'chayushchego apparata na energoyemkost' protsessa rezaniya / Vladimyr Kuzmenko, Oleksandr Kholodiuk // Motrol: Motorization and power industry in agriculture. – 2016. – Tom 18, № 3. – P. 262–271. [in Ukrainian].

6. Rustamov S.I. Vysokoproizvoditel'nyye rezhushchiye apparaty sel'skokho-zyaystvennykh uborochnykh mashin / S.I. Rustamov. – Kiyev-Donetsk: Vishcha shkola, – 1985. – 95 s. [in Ukrainian].

7. Daurskiy A.N. Rezaniye pishchevykh materialov: teoríya protsessa, mashiny, intensifikatsiya / A.N. Daurskiy, YU.A. Machikhin. – M.: Pishchevaya prom-st', 1980. – 240 s. [in Russian].

УДК. 621.3

Швец Людмила Васильевна
Кандидат технических наук, доцент
Винницкий национальный аграрный университет, Винница, Украина
DOI: 10.24412/2520-6990-2021-895-44-53

ВОССТАНОВЛЕНИЕ КОРПУСНЫХ ДЕТЕЛЕЙ

Shvets Ludmila
PhD, Associate Professor
Vinnytsia National Agrarian University, Vinnytsya, Ukraine

RESTORATION OF BODY PARTS

Аннотация.

Корпуса представляют собой детали коробчатой формы с наличием базовых плоскостей и координированных с ними и между собой точных посадочных отверстий.

Основное назначение корпусных деталей - обеспечение заданного взаимного расположения различных сборочных единиц в течение заданного промежутка времени (ресурса) как в статическом состоянии, так и при заданных режимах эксплуатации, плавности их работы, а также выполнение ряда функциональных назначений (герметизация, теплоизоляция и др.).

Конструкции корпусных деталей разные. Условно можно выделить два основных типа корпусных деталей: призматические и фланцевые. Для первого типа характерно наличие развитых наружных плоскостей и основных отверстий на нескольких осях. В деталей второго типа плоскостями служат торцевые поверхности основных отверстий с центрирующими выточками, буртами, которые определяют их обработку точением.

В работе разработано приспособление для востановления посадочных мест для коренных подшипников двигателей внутреннего сгорания.

Abstract.

Housings have the form of a box-shaped part with the presence of base planes and precise landing holes, coordinated with each other.

The main purpose of the body parts is to ensure a given mutual placement of different assembly units for a certain period of time (resource) both in static state and at given modes of operation, uninterrupted operation, as well as a number of functional purposes (sealing, insulation, etc.).

Designs of case details are various. There are two main types of body parts: prismatic and flanged. The first type is characterized by the presence of developed outer planes and main holes on several axes. In parts of the second type, the planes are the end surfaces of the main holes with centering recesses, flanges, which determine their machining turning.

In the work, a device has been developed for restoring the seats for the main bearings of internal combustion engines.

Colloquium-journal №8(95), 2021

Część 1

(Warszawa, Polska)

ISSN 2520-6990

ISSN 2520-2480

Czasopismo jest zarejestrowany i wydany w Polsce. Czasopismo publikuje artykuły ze wszystkich dziedzin naukowych. Magazyn jest wydawany w języku angielskim, polskim i rosyjskim.
Częstotliwość: co tydzień

Wszystkie artykuły są recenzowane.
Bezpłatny dostęp do elektronicznej wersji magazynu.

Czasopismo jest publikowane i indeksowane na portalu eLIBRARY.RU,
Umowa z RSCI nr 118-03 / 2017 z dnia 14.03.2017.

Redaktor naczelny - **Paweł Nowak, Ewa Kowalczyk**

«Colloquium-journal»
Wydrukowano w Annopol 4, 03-236 Warszawa Poland, «Interdruk»
Format 60 × 90/8. Nakład 500 egzemplarzy.

E-mail: info@colloquium-journal.org

http://www.colloquium-journal.org/